Process Chain in Automotive Industry

Present-day Demands versus Long Term Open CAD/CAM Strategies

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Abstract

The automotive industry was a pioneer in using CAD/CAM technology. Now the car manufacturers development process is almost completely done with this technology. Substantial initiative for the standardisation of CAD/CAM technics comes from the automotive industry, as e.g. for neutral CAD data interfaces. The R&D departments of German car manufacturers have founded a working group[ii] with the aim to develop a common long term CAD/CAM strategy. One important result is the concept of a future CAx[iii] architecture based on the standard data structure STEP[iv]. The commitment of the car manufactures to STEP and open system architectures is in contradiction to their attitude towards suppliers and subcontractors: Recently, more and more contractors are contractually bound to use exactly the same CAD system as the orderer.

The German car industry tries to find a way out of this contradiction and to improve the co-operation between the companies in short term. Therefore they proposed a "Dual CAD Strategy", i.e. to put improvements in CAD communication into practice which are possible today - even proprietary solutions - and in parallel to invest in strategic concepts to prepare tomorrow´s open system landscape.

1. Industrial Situation

The present situation in the automotive industry is characterised by the requirements of the world market with enormous international competition. Highest possible quality, quick response to the demands of the market (following customer trends by reducing time-to-market), reduction of costs - these are the known conditions which control today´s automotive market. In addition to these three goals, the companies need more and more new, innovative products to set off against international competitors. To meet with these challenges, the companies adjust their product development as follows:

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[iii] CAx : CAD, CAM, CAQ, CAP, CAE, ...

[iv] STEP : **S**tandard for **T**ransfer and **E**xchange of **P**roduct data - ISO 10303

- Reducing the period of development
- Optimising the in-house development depth
- Modularising the product
- Reducing the in-house production depth
- Increasing the number of products / varieties.

The following steps are connected to these strategies:

- Concentration on core business
  (design, car body, entire car)
- World-wide selection of developing partners and suppliers (Forward / Global Sourcing)
- Introduction of new working methods (Simultaneous Engineering, Concurrent Engineering, Process Network)
- Usage of highly sophisticated functions of CAD systems (Parametrics, Features, Digital Mock Up)
- Early concept evaluation (computation and simulation).

Running the product definition process successfully is only possible with a functioning communication

- between company-internal business units / departments
- between different enterprises
- between the different information technology (IT) systems - not only CAx systems
- between people.

To support the product definition process, communication will mainly focus on

- design results
- design methodology / know-how
- technical, non-constructive information (testing results, production know-how,...)
- structure information (list of items,...)
- administrative, logistical information
  (planning development- and production control information).

Conventionally, the information flow was performed passively, i.e. via file exchange or (in former times) by transfer of paper drawings or physical models. Until today, a lot of effort was put into "active information exchange", namely CA-conferencing (distributed design) and Multimedia application within the process (e.g. video-conferencing)

2. CAx-Technology / Strategic Requirements

The fast changes in the industrial processes are closely connected to the changes in the CAx technology. Thus, technology is an important aid for industrial companies to fulfil their objectives required by the global competition. The strategic working group of the five car manufacturers formulated several strategic priorities:

- Integration of dynamic processes / process elements
- Overall control of product information flow in the entire process
- Flexible and economic CAx technology: only possible through standards
- Meeting the demands of communication

- CAx functionality: general possibility to create any required tool
- Decentralisation
- Open systems / co-operation between users and suppliers
- Reduction of costs and expenses for technology and applications

Derived from these strategies of the automotive companies, an open CAx system architecture was developed as a basis for future developments of system vendors (Fig. 1[1 2]).

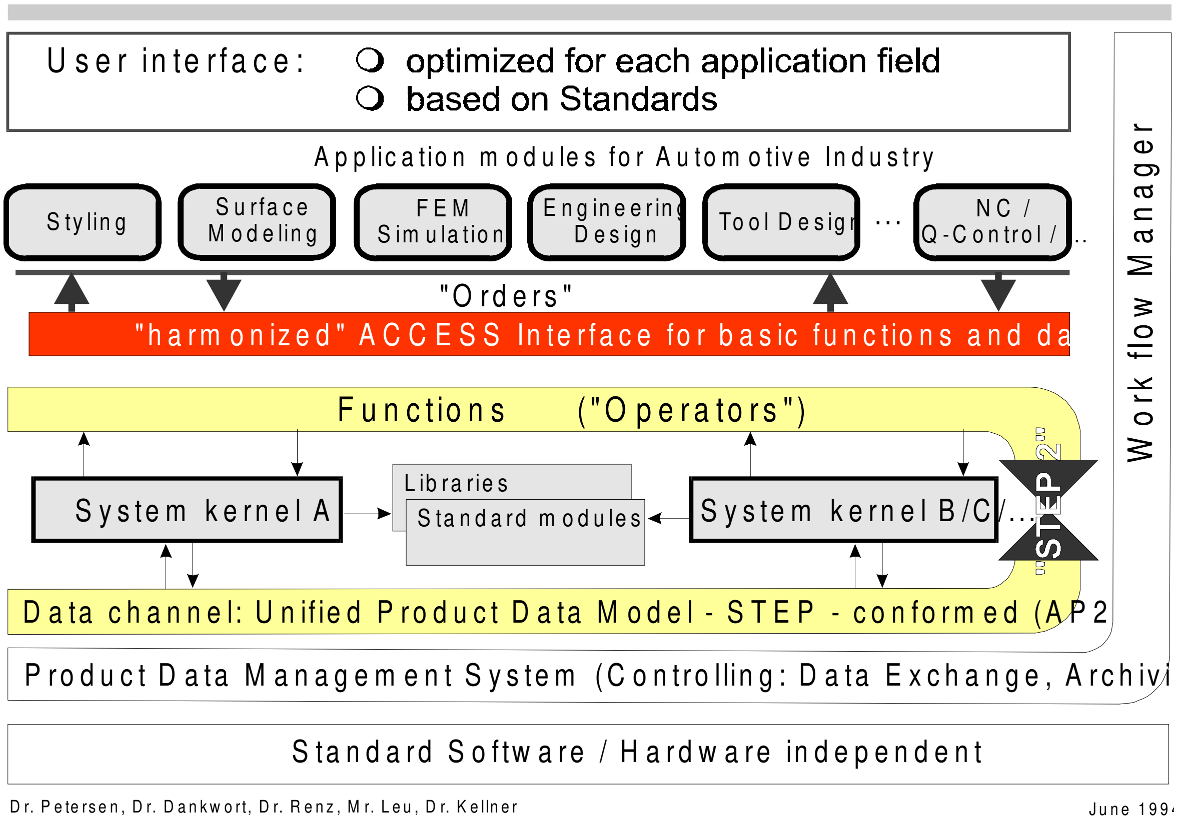

Fig. 1: CAx System Architecture of the Future

As a result of the open system architecture, **the** CAx system does not exist anymore. The future CAx system world has a strictly modular structure, i.e. ready-made out of building blocks and tools from different suppliers depending on the requirements of the user and separation of data (STEP compliant), databases, functions, system kernels and user interfaces. The proposed system architecture is based on standards and is hardware independent. The access interfaces are adjusted to data, functions and applications.

Although the commitment of manufacturers is directed towards open systems and enormous effort has been done to introduce neutral data interfaces to every day usage of CAx communication, reality looks quite different. Data exchange delays flow and development processes (expensive functional deficiencies and delays). Yet, there is no solution to STEP problems (STEP processors can only convert subsets of data; standardisation slower than expected; extensions are necessary, however, they are so far only in planning).

Therefore, car manufacturers require from their subcontractors to deliver CAx data in the native format of the orderers´ CAx system. Their expectations are:

- CAD data transfer without loss
- Improved communication between orderer and supplier:
  identical "CAD-language", identical CAD-specific methods
- Data exchange processes technically simpler and cheaper than with conversions
- Support of Simultaneous Engineering conceivable
- Passing-on of design know-how facilities.

Summarised, the motto of managers and engineers working on a car project is:

> The TODAY has to be managed primarily -
> The TOMORROW has yet to be made ready for production.

The point of view of suppliers, subcontractors or co-developer is quite different: Together with the car manufacturers they form a development network, i.e. these companies do not work for just one car manufacturer but receive different kinds of orders from all car manufacturers. Because of this subcontractor structure, the co-operation between car manufacturers and suppliers is very complex. Due to the demands of the automotive industry, the external partners have to provide various CAD systems. The competitiveness of suppliers and subcontractors - when applying for an order from a car manufacturer - does no longer primarily depend on the know-how of the company but also on the existence of a specific CAD system required by the orderer.

The suppliers claim the following disadvantages caused by the CAx data exchange in native formats:

- Optimisation of own processes is impossible
- Standardisation of parts is prevented
- High additional costs by "system zoo"
- Additional training costs
- No optimal utilisation of working capacities.

A working group with representatives from 15 companies and the VDMA (Association of German Mechanical Engineers) has carried out a rough analysis in the ProSTEP-Association showing that additional expenditures of 190 Million German Marks arise from data exchange and the simultaneous operation of several CAx systems at supplier companies.[3] Economically, this increase in price of the general process leads to a decrease of the competitive capacity of the automotive industry as a whole (manufacturers and suppliers).

3. CAD Dual Strategy

As a solution to the - evident or seeming - contradictions, the German automotive industry has developed the CAD Dual Strategy based upon the primary goals and demands of both groups of interest, i.e. car manufacturers and suppliers:

- Achieving data exchange and data sharing on the basis of STEP
- Facilitation and improvement of CAD operation right away in feasible steps

- Meeting the demands of communication; supporting the information flows in the overall process
- Independence of user companies from CAx system suppliers concerning hardware and software
- Economic efficiency and flexibility of CAx engineering based on standards, i.e. openness and modularity of CAx systems, openness and co-operation of system suppliers

Data exchange with native files is certainly not a primary goal of the German automotive industry. The industry has to expect a heterogeneous system scenery.

So, how is the CAD Dual Strategy defined? The answer is:

„Improvements - even with proprietary solutions - feasible today have to be put into practice, and at the same time strategic concepts have to be evolved to prepare tomorrow´s open system landscape for a smooth communication.“(Fig. 2)

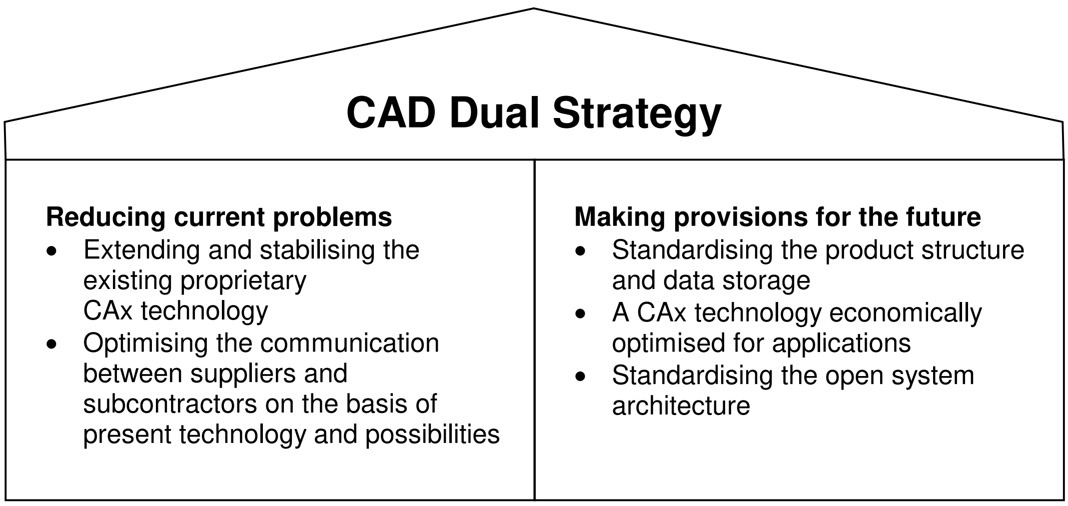

Fig. 2: CAD Dual Strategy

The usage of proprietary CAD systems is inevitable for a conceivable period of time but even with them, short term improvements can be achieved. In doing so, it is important to keep in mind the long term requirements (STEP, hardware and software independence) because it is necessary to bring together geometric and structural data. However, this is not possible without STEP.

Furthermore, a continuous development of CAx technologies without cutoff is postulated for the change from solving short term problems to accomplishing strategic goals.

4. Steps for the Realisation of the CAD Dual Strategy

An important aspect for the plausibility of a strategy is the path of realisation. A whole bundle of measures are planned complementing each other logically as well as technically and they are partially based on each other. Hereby, the temporal aspect has to be considered, i.e. whether the actions will be effective in short or medium term.

4.1 Activities to Control Current Problems - Effective in Short Term

The present co-operation of companies in the CAD sector can be improved tremendously with possibilities available today (cf. left column of CAD Dual Strategy in Fig. 2).

I Optimising the Usage of Identical Systems (Native Files)

A working group of common interest has been founded for a widespread CAD/CAM system to reduce the manifold system-technical difficulties in the communication by arrangements and corporate problem treatment. The results are also available to the partners of the car manufacturers. User interests can be presented to the system supplier more competent and effective by the working group.

II Using Guidelines of the Automotive Industry Association

Considering the different company workflows and the utilisation of available CAD technology, the CAD data exchange is far from being optimal. Early inclusion and correct observance of existing guidelines and recommendations reduce several problems, save time and money (Guideline for data exchange, for data quality, for data evaluation, contracts for data exchange, ...).

III CAD Communication

Even more potential for optimising data exchange can be reached by analysing flows of CAD communication. The following facts are evident (Fig. 3):

- Data exchange is carried out in native formats even if using neutral formats would be as good (or better).
- Data is exchanged which is not at all or not as often needed for the workflow:
  - Often HPGL, TIFFG4 or PS (drawing) formats are more helpful for easy communication beyond company borders.
  - CAD model files contain a lot of information not needed by the receiving person causing unnecessary effort.

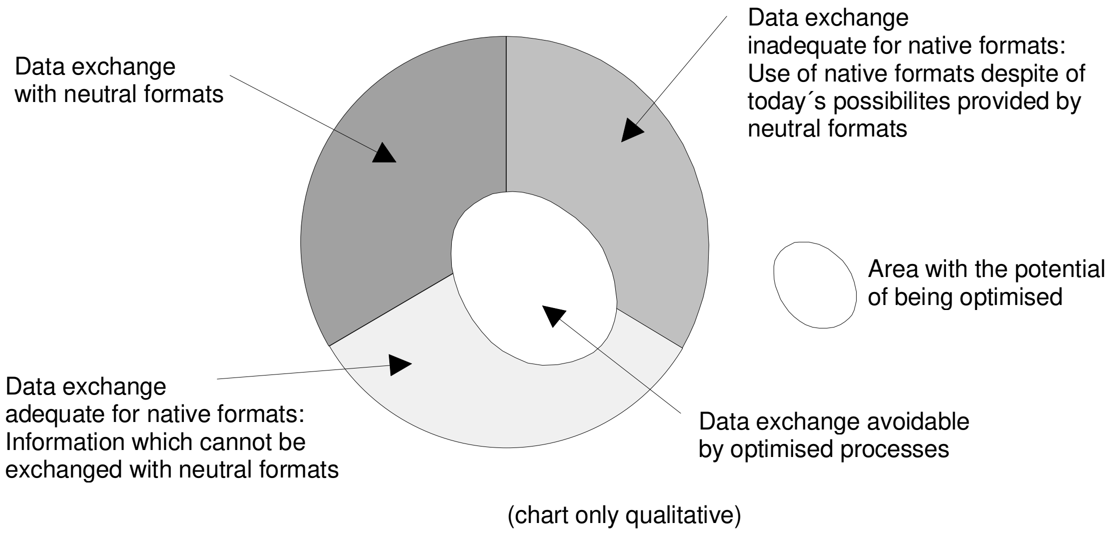

Fig. 3: Principal possibilities of CAD Data Exchange

IV CA-Conferencing

Methodical working procedures such as e.g. Simultaneous Engineering (S.E.) are needed for developing products beyond plant and company borders especially with respect to optimised development depth within the automotive companies. First of all, communication tools which are accessable to all involved partners are needed for these working procedures reducing data exchange, permitting transparent arrangements, and minimising idle time, e.g. caused by travelling. CA-Conferencing supports and optimises communication processes. The functional possibilities of this technology were analysed by a working group. Starting in 1996, know-how about these tools has been gathered, functional requirements have been proposed for the tools, and workflows have been optimised in co-operation with the suppliers.

V STEP Pilot Projects

Pilot projects are set into practice with internal and external partners promoting data exchange with STEP processors. Headed by the ProSTEP-organisation, new STEP-processors developed by the system vendors are tested to prove their industrial usability.

4.2 Operational Activities / Projects - Effective in Medium Term

All companies require transparency and openness of the CAx system scenery. The CAx system suppliers are asked to build their architectures on standards and to follow the proposed framework of the automotive industry. The co-operation in the project ANICA shows the increasing correspondence between thoughts of the automotive industry and concepts of large CAx system suppliers. Some - but not enough - innovative CAx system suppliers change to STEP-based internal data structures. This offers the perspective for a considerable reduction of data exchange problems.

I Analysis of Access Interfaces of Various CAx Systems (ANICA)

To verify the feasibility of this new CAx architecture, the project ANICA (Analysis of Access Interfaces of Various CAx Systems) is carried out by the Research Group for Computer Application in Engineering Design at the University of Kaiserslautern. It is supported by the German automotive industry, the Rhineland-Palatinate Foundation for Innovation as well as the system suppliers Computervision, Dassault/IBM, Intergraph, Matra Datavision, Spatial Technology and Tecmath. The aim of the project is to analyse the interfaces of conventional CAx systems in order to develop a concept for a common harmonised access interface and thus achieve a component-oriented integration of heterogeneous CAx systems (Fig. 1). Thereby the components provide the necessary CAx functionality and the interface interlinks the components enabling the user to call functions across system and platform borders (Fig. 4). This approach of interoperability between CAx objects is based on CORBA and the STEP hierarchy of entities. But since these STEP entities are pure data descriptions, suitable methods have to be added to form complete and reasonable classes.[4 5]

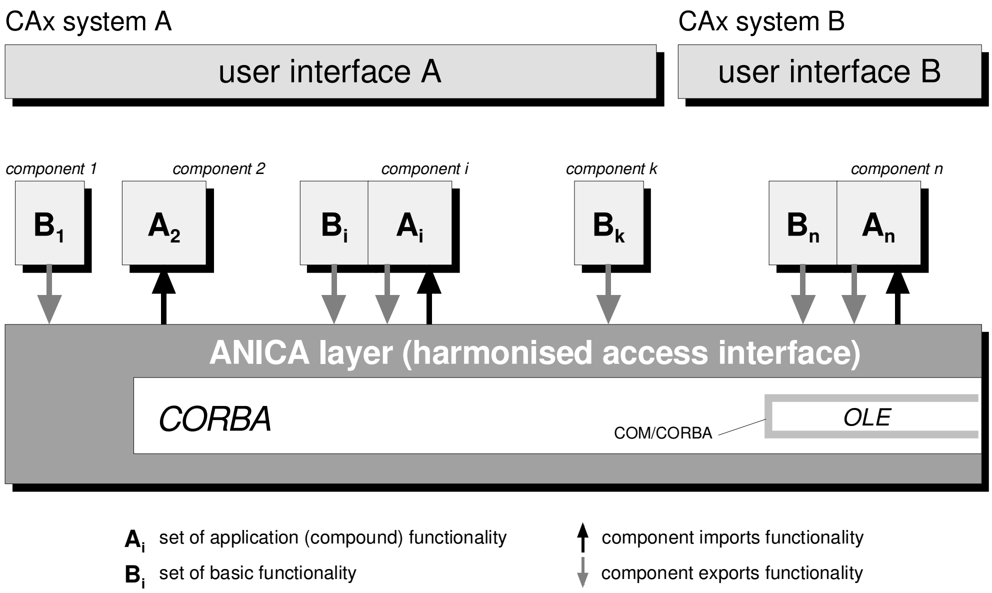

Fig. 4: ANICA: Access interfaces as basic modules for a distributed and object-oriented CAx system

II Integration of Administrative Data

The integration of administrative data - especially bills of material - and conventional CAD data will tremendously improve workflows. In a European working group, companies co-operate to specify STEP based structures for bills of material which can be exchanged. With the help of the ProSTEP society these results are integrated in the international standard.

III Investments in STEP

Today "information" is an additional production factor. Phases of the product development process are defined in the Application Protocol 214 which will be standardised soon. The automotive industry provides about 1 million DM annually for the conclusion and implementation of these activities. Further important points as e.g. Multi Body Simulation, FEA, Features, Parametrics etc. have to be discussed within the next few years. In Germany, the realisation is carried out by the ProSTEP initiative which has been initiated by the automotive industry.

More and more, these strategic criteria form the basis for CAx decisions in the automotive industry. The commitment to a heterogeneous system scenery results in a reserved attitude towards monopolists. However, this does not mean at all that suppliers with a strong market position will be excluded as long as they support modern and open CAx strategies.

The strategic working group of German car manufacturers discusses these concepts with car part suppliers as well as with CAx system suppliers. Only a constructive and open dialogue will bring success in this complex field.

5. Consequences for Application Companies and System Suppliers

The discussed problems are far from being solved. But there are consequences for all involved partners:

- Car manufacturers have to set needed activities into practice. The subcontractors have to be able to rely on them.
- Car manufacturers and subcontractors have to integrate the results in automotive projects.
- Subcontractors have to realise that native formats will still be necessary for certain tasks in the near future.
- CAx system suppliers have to adopt the elaborated concepts in their product planning and realise them efficiently.
- The vendors will enter a new phase of tasks: They will have to support processes within the manufacturing industry using software from different competing enterprises.

The realisation of activities listed in chapter 4 will automatically result in a reduction of native format based in favour of STEP-based data exchange. Even more important than the consideration of changes in the CAD technology is the necessity to accept and set into practice alterations in thinking and co-operation of partners.

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